Alternative wood products from blue-stained mountain pine beetle lumber: non-structural laminated products

I. Zaturecky and I. Chiu

Mountain Pine Beetle Initiative
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Abstract

This study evaluated the potential of blue-stained lodgepole pine wood to be used for nonstructural appearance-grade laminated panels. Two methods of processing—edge gluing and face lamination—were studied. Both faces of each panel were graded for amount of stain and appearance, and recovery numbers were recorded during the process to complete the evaluation.

Of the edge-glued panels, those with a natural streak appearance were most appealing. The uniform stripe design and the alternating stripe design were least appealing. The edge-gluing method was more conducive to the manipulation of panel appearance, thereby allowing a greater recovery of the non-stained portion of production than was the face lamination method. Of the face-laminated panels, those with marbled design were most appealing. This method could not produce the natural streak design and also has limited capabilities in sorting the non-stained portion of the wood.

Key words: mountain pine beetle, *Dendroctonus ponderosae*, blue stain, wood processing, laminates, panelling, lodgepole pine, *Pinus contorta*, wood products, edge gluing, face lamination, market appeal

Résumé

La présente étude évalue la possibilité d'utiliser du bois de pin tordu latifolié bleui pour fabriquer des panneaux de finition lamellés à usage non structurel. Deux procédés de fabrication par encollage – de chant et de face – ont été évalués. Les deux faces de chaque panneau ont été classifiées d'après la quantité de bleuissement et l'aspect; le taux de récupération associé à chaque procédé a également été pris en compte aux fins de l'évaluation.

Parmi les panneaux produits par encollage du chant, ceux qui montraient un aspect strié naturel présentaient le plus grand attrait commercial. Les panneaux à motifs de rayures uniformes et de rayures alternantes présentaient le plus faible attrait commercial. En comparaison de l'encollage de face, l'encollage du chant s'est mieux prêté au travail de l'aspect des panneaux et a ainsi permis une récupération plus efficace des parties non bleuies. Parmi les panneaux obtenus par encollage de face, ceux qui montraient un aspect marbré présentaient le plus grand attrait commercial. Toutefois, cette méthode n'a pas permis de produire des panneaux présentant un aspect strié naturel, et elle a ses limites pour ce qui est du tri des parties non bleuies.

Mots clés : dendroctone du pin ponderosa, *Dendroctonus ponderosae*, bleuissement, transformation du bois, panneaux lamellés, mise en panneau, pin tordu latifolié, *Pinus contorta*, produits ligneux, encollage du chant, encollage de face, attrait commercial

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Introduction

Infestation of lodgepole pine by mountain pine beetle in British Columbia is increasing dramatically. From 2001 to 2002, the volume of beetle attacked wood increased from 72 million cubic meters to 108 million cubic meters. The British Columbia Ministry of Forests assumes that 50% of mature pine (older than 80 years) will be killed. To date, approximately 9 million hectares of lodgepole pine stands in the central interior of the province has been dead for 1 to 2 years (red-attacked). Stands that have been dead for 3 to 4 years are classified as grey-attacked. The shelf life of killed mountain pine beetle wood is estimated to be 15 years. Consequently, the Ministry of Forests has increased annual allowable cuts in beetle-infested timber supply areas for the next 15 years. Even with this conservative estimate of affected mature pine and the increase in annual allowable cuts, there will be about 200 million cubic meters of dead standing pine after 15 years (Petersen 2004).

The two major markets for British Columbia's spruce–pine–fir lumber (SPF) are the North American dimensional lumber market and the Japanese 2 x 4-in. construction lumber market. The Japanese Agricultural Standards- (JAS-) grade lumber specified for the Japanese 2 x 4-in. construction does not permit stain. Although the current grades for the North American housing market allow some stained lumber, an increase in quantity of blue-stained pine in the mix may encounter consumer resistance.

Some efforts have been made to promote the uniqueness of blue stain for appearance-type products. A small group of manufacturers and locals around Quesnel, British Columbia, have been promoting blue-stained wood under the name, "Denim Pine". The idea behind these efforts is to convince consumers that blue stain adds character to wood and to finished products such as furniture, cabinets, flooring, panelling or shelving (http://www.denimpine.ca).

In this study, we evaluated the acceptability of more uniformly stained wood products for non-structural laminated products. Our specific target was to use lumber with varying degrees of blue stain and cut at a dimensional sawmill to manufacture panel or shelving products by using various laminating techniques. Panel appearance was assessed for attractiveness and potential applications.

Methods and results

Manufacturing of edge-glued panels

One package of 2.13-metre-long (84-in.) 38 mm x 89 mm (nominal 2 x 4 in) stud-grade lumber was used. Lumber was pulled out after the planer, based on the presence of at least 50% blue stain on one face. Moisture content was measured, and the lumber was stickered and air dried to 12% to 14% moisture content. The lumber was ripped to a target size of 20 mm thickness, producing strips that were 20 mm x 38 mm in size. The strips were sorted into three grades, based on amount and location of blue stain. Grade One had no stain on the piece, Grade Two contained stain on one face, and Grade Three consisted of stain on two faces. (Grade outturn is shown in Table 1.) Pieces with two-sided stain were sorted again for appearance, and put together into sets prior to edge gluing.

Table 1. Grade Outturn

Grade:		# Pieces	%
1	No Stain	42	3.7%
2	Single Stain	40	3.6%
3	Double Stain	1 044	92.7%
	Total	1 126	100%

Edge-glued panels were produced with Dural's PVA adhesive G2539, using a hot press made by Kallesoe. Pressing parameters included a platen temperature of 90°C, and a press time of 20 minutes using a press-specific pressure of 828 kPa (120psi).

Using a total of nine strips, the edge-glued panels were 314 mm (12 3/8") wide. Several different designs were produced by mixing and matching pieces together. A total of 68 edge-glued panels were produced. Each panel was visually graded for amount of blue stain and appearance. The amount of stain ranged from 0% to 95%. Terms used to describe blue-stain patterns on the panels are as follows: no stain, uniform, very uniform, uniform stripe, alternating stripes, random, random marbled, random scattered, random blotched, few scattered, and natural streaks.

Both faces of each panel were graded for amount of stain and appearance. The amount of stain on each face of a given panel was visually estimated. After visually assessing the amount of blue stain on a face, the face was evaluated for appearance.

Table 2 shows the amount of stain and appearance of the edge-glued panels. The first column contains the code which identifies the panel. For example, 59a refers to Side A of panel 59 and 59b refers to Side B of panel 59. The second column contains information on amount of stain in terms of percentage. Appearance of the face is described in the third column. Terms used to describe the blue-stain patterns are defined in Appendix 1.

Table 2. Edge-glued panels

Code	%Stain	Appearance
59a	0	no stain
59b	0	no stain
58a	0	no stain
58b	0	no stain
57a	0	no stain
57b	0	no stain
60a	0	no stain
60b	0	no stain
53a	20	uniform stripe
53b	30	uniform stripe
54a	95	uniform
54b	90	uniform
49a	15	uniform stripe
49b	20	uniform stripe
50a	45	very uniform
50b	45	very uniform
51a	40	marbled random
51b	35	random
41a	25	uniform stripe
41b	20	uniform stripe
42a	40	alternating solid stripe
42b	40	alternating solid stripe
48a	10	random scattered
48b	15	random scattered
30a	30	uniform stripe
30b	30	uniform stripe
40a	75	uniform
40b	65	uniform
39a	5	few scattered
39b	5	few scattered
36a	50	random
36b	50	marbled random
35a	10	random
35b	10	random
33a	35	uniform stripe
33b	30	uniform stripe
25a	40	random
25b	50	random
32a	25	random
32b	25	random
31a	25	random
31b	25	random
23a	35	uniform stripe

Code	%Stain	Appearance
23b	40	uniform stripe
22a	85	uniform
22b	80	uniform
24a	25	uniform stripe
24b	25	uniform stripe
20a	40	natural streaks
20b	40	random streaks
14a	40	natural streaks
14b	40	natural streaks
18a	40	uniform stripe
18b	30	uniform stripe
19a	90	uniform
19b	80	uniform
16a	80	uniform
16b	70	uniform
15a	25	uniform stripe
15b	30	marbled random
4a	30	random
4b	30	random
5a	95	uniform
5b	90	uniform
6a	50	random
6b	55	random
68a	0	ns
68b	0	ns
67a	0	ns
67b	0	ns
66a	0	ns
66b	0	ns
65a	5	random
65b	10	random
63a	0	ns
63b	0	ns
64a	5	random
64b	0	ns
62a	15	random blotched
62b	0	ns
61a	0	ns
61b	0	ns
52a	90	uniform
52b	75	uniform
56a	25	random
56b	20	random
55a	30	uniform stripe

Code	%Stain	Appearance
55b	30	uniform stripe
47a	75	natural streaks
47b	50	random
46a	60	natural streaks
46b	60	natural streaks
45a	60	random marbled
45b	60	random marbled
43a	75	random
43b	75	random
44a	10	random
44b	15	random
37a	35	random
37b	35	random
34a	25	random
34b	30	random
29a	50	uniform stripe
29b	65	uniform stripe
38a	60	alternating stripes
38b	50	uniform stripe
27a	50	uniform stripe
27b	50	uniform stripe
28a	40	alternating stripes
28b	50	alternating stripes
26a	50	marbled
26b	30	random

Code	%Stain	Appearance
21a	40	uniform stripe
21b	40	uniform stripe
17a	25	random
17b	35	random
13a	40	uniform stripe
13b	40	uniform stripe
12a	25	uniform stripe
12b	25	uniform stripe
10a	40	uniform stripe
10b	40	uniform stripe
9a	90	uniform
9b	75	uniform
11a	15	random
11b	15	random
7a	25	random
7b	25	random
8a	40	uniform stripe
8b	40	uniform stripe
3a	15	random
3b	15	random
2a	40	uniform stripe
2b	40	uniform stripe
1a	50	marbled
1b	40	marbled

Manufacturing of face-laminated panels

A second package of 2.13-metr-long (84-in.) 38 mm x 89 mm (nominal 2 x 4 in.) stud-grade lumber was used. The same grade of lumber as used in the previous section was selected, re-dried to 12% to 14% moisture content and processed. Lumber was planed to a thickness of 35 mm and the width of 86 mm. After planing, the lumber was sorted into two grades: Grade One consisted of lumber with blue stain on one face; Grade Two had blue stain on both faces.

Before face gluing, pieces were sorted again, based on amount and pattern of blue stain.

The blue-stained lumber was pre-sorted into blocks before glue application. Laminated blocks with dimensions 89 mm x 305 mm x 2.13 m (3.5 in. x 12 in. x 84 in.) were produced with PVA adhesive from Dural G2539, using a Kallesoe hydraulic hot press. Pressing parameters included a platen temperature of 90°C, and a press time of 20 minutes with a press-specific pressure of 828 kPa (120 psi).

A total of 20 blocks were made. Three panels, each measuring 25.4 mm (1") thick, were sawn from each block. The panels were graded visually for amount and appearance of stain on both faces, using the same methodology as was used to grade the edge-glued panel set. (See Table 3 for details on amount of stain and visual appearance of each board.)

Table 3. Face-laminated panels

Sample	% Stain	Appearance
1-1a	95	uniform
1-1b	60	random stripes
1-2a	55	random stripes
1-2b	5	scattered few
1-3a	5	scattered few
1-3b	0	no stain
2-1a	70	alternating stripes
2-1b	15	random scattered
2-2a	15	random scattered
2-2b	5	few stripes
2-3a	5	few stripes
2-3b	5	few stripes
3-1a	100	uniform
3-1b	60	blotched
3-2a	60	blotched
3-2b	15	few stripes
3-3a	15	few stripes
3-3b	0	no stain
4-1a	40	alternating stripes
4-1b	20	alternating stripes
4-2a	20	alternating stripes
4-2b	10	scattered stripes
4-3a	10	scattered stripes
4-3b	5	few stripes one side
5-1a	70	gradient
5-1b	40	random
5-2a	40	random
5-2b	10	scattered
5-3a	10	scattered
5-3b	15	uneven
8-1a	70	uniform
8-1b	40	mixed stripes
8-2a	40	mixed stripes
8-2b	20	mixed stripes
8-3a	20	mixed stripes
8-3b	30	mixed stripes
6-1a	95	marbled

Sample	% Stain	Appearance
6-1b	80	marbled
6-2a	80	marbled
6-2b	15	few stripes
6-3a	15	few stripes
6-3b	5	few stripes
7-1a	50	uniform stripe
7-1b	30	uniform stripe
7-2a	30	uniform stripe
7-2b	30	uniform stripe
7-3a	30	uniform stripe
7-3b	40	uniform stripe
11-1a	65	uniform stripe
11-1b	20	uniform stripe
11-2a	20	uniform stripe
11-2b	35	uniform stripe
11-3a	35	uniform stripe
11-3b	60	uniform stripe
10-1a	35	marbled
10-1b	25	uniform stripe
10-2a	25	uniform stripe
10-2b	30	uniform stripe
10-3a	30	uniform stripe
10-3b	70	marbled
9-1a	95	uniform
9-1b	80	uniform
9-2a	80	uniform
9-2b	50	uniform
9-3a	50	uniform
9-3b	65	uniform
14-1a	95	uniform
14-1b	50	uniform
14-2a	50	uniform
14-2b	35	random
14-3a	35	random
14-3b	25	random
13-1a	90	uniform
13-1b	50	uniform
13-2a	50	uniform

Sample	% Stain	Appearance
13-2b	40	uniform
13-3a	40	uniform
13-3b	40	uniform
12-1a	85	uniform
12-1b	40	uniform
12-2a	40	uniform
12-2b	30	uniform
12-3a	30	uniform
12-3b	40	uniform
17-1a	50	uniform
17-1b	35	uniform
17-2a	35	uniform
17-2b	50	uniform
17-3a	50	uniform
17-3b	75	uniform
16-1a	30	uniform
16-1b	20	uniform
16-2a	20	uniform
16-2b	20	uniform
16-3a	20	uniform
16-3b	30	uniform
15-1a	50	uniform stripe
15-1b	30	uniform stripe

Sample	% Stain	Appearance
15-2a	30	uniform stripe
15-2b	30	uniform stripe
15-3a	30	uniform stripe
15-3b	40	random stripes
19-1a	80	marbled
19-1b	65	marbled
19-2a	65	marbled
19-2b	50	marbled
19-3a	50	marbled
19-3b	50	marbled
18-1a	95	uniform
18-1b	80	uniform
18-2a	80	uniform
18-2b	70	uniform
18-3a	70	uniform
18-3b	80	uniform
20-1a	40	uniform stripes
20-1b	15	random stripes
20-2a	15	random stripes
20-2b	25	random stripes
20-3a	25	random stripes
20-3b	30	random stripes

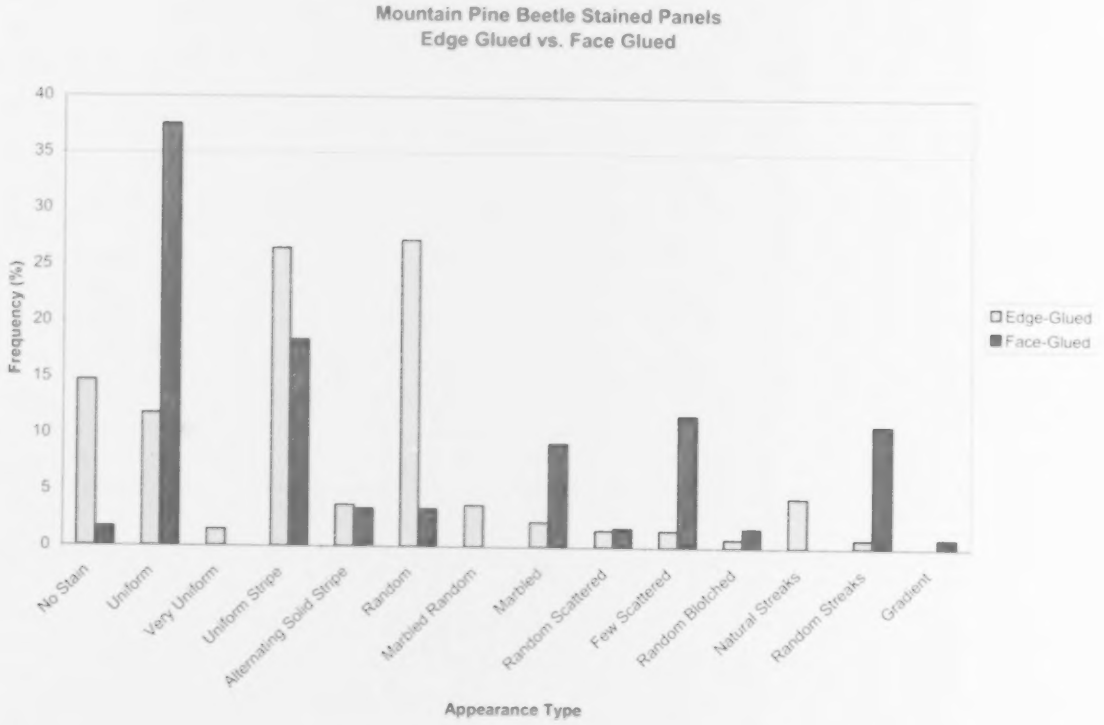
Assessing attractiveness of blue-stain patterns on panels

Attractiveness, or visual appeal, of different patterns produced from the edge-glued and laminated blue-stained pine lumber was assessed according to the ability of the lay-up to resemble the natural look of custom-cut boards from the same type of log. Custom cutting of logs uses a cutting pattern that differs from that used in dimensional sawmills, and produces natural-looking, mostly flat-grain boards. This is a preferable method to produce furniture components or stock in which appearance is a factor. The most desirable patterns in edge-glued and face-laminated panels looked very natural, with glue lines completely hidden: it was similar in appearance to boards cut from mountain pine beetle-killed logs. The least desirable pattern looked artificial, with glue lines clearly visible: the panels differed greatly in appearance from boards cut from mountain pine beetle-killed logs.

Discussion

Summarized data for all panels was graphed and is shown in Figure 1.

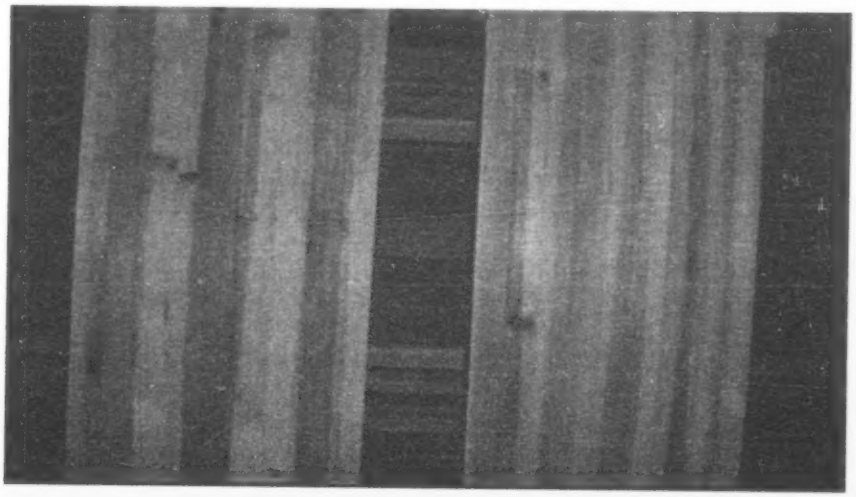
Figure 1. Summarized panel data



Edge-glued panels

Panels made with a natural streak design (Figure 2) were the most desirable. The glue lines between the strips were hidden within the blue stain; this produces a natural-looking design. It also compares to boards sawn specifically for appearance for flooring or panelling. These results indicate that lumber from dimensional sawmill can be successfully used for value-added products and compete against custom-cut lumber.

Figure 2. Left: 50% natural streak; right: 40% natural streak



The uniform stripe (Figure 3) and alternating stripe design (Figure 4) were least desirable in appearance compared to the natural streak design.

Figure 3. Left: 40% uniform stripe; right: 25% uniform stripe

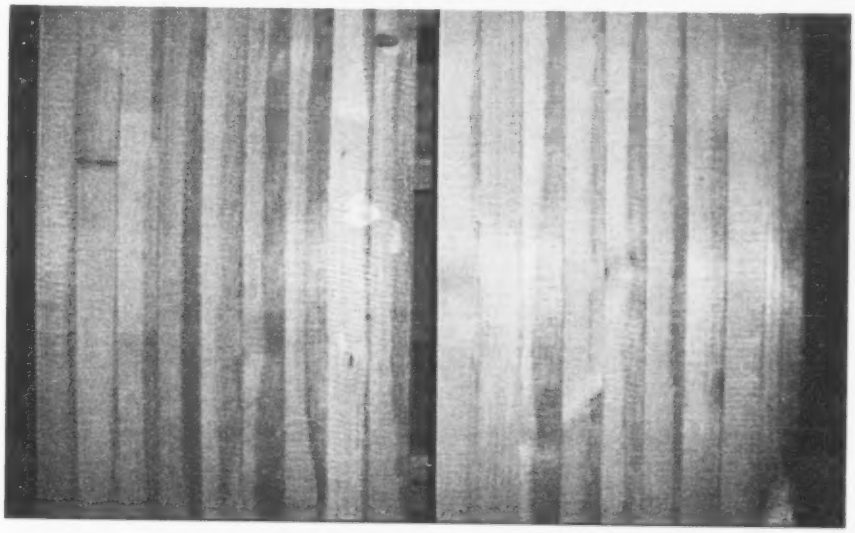
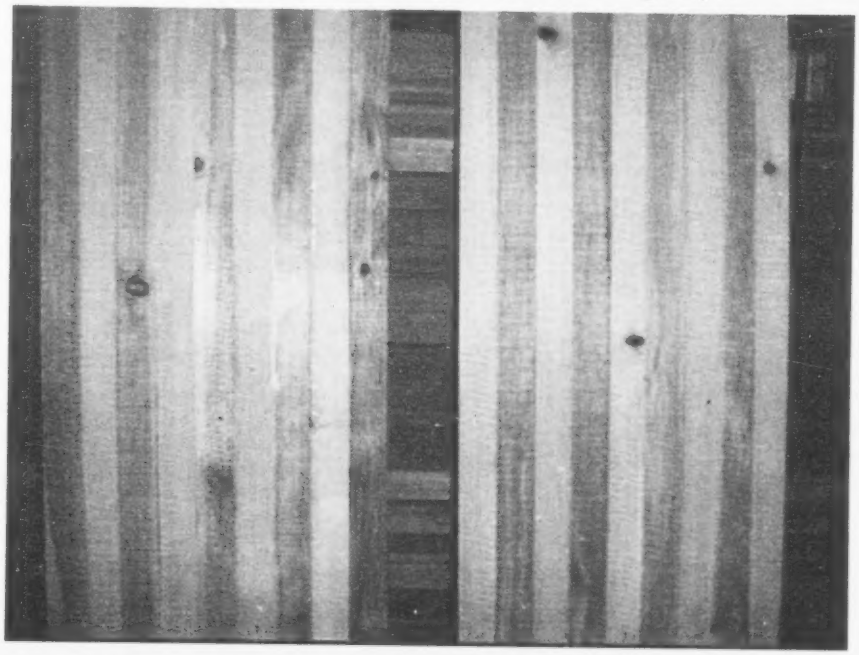
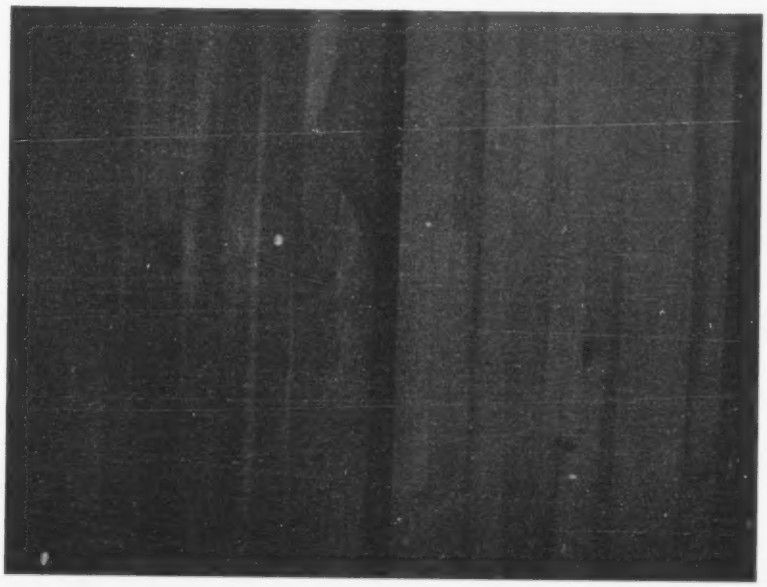


Figure 4. Left: 60% alternating stripe; Right: 50% alternating stripe



Panels made with uniform (Figure 5), random (Figure 5), and marbled designs were more visually appealing than were the uniform and alternating stripe designs, but less appealing than was the natural streak design.

Figure 5. Left: 90% Uniform; Right: 25% Random



Face-glued panels

For the face-laminated samples in this set, no panels were produced with a natural streak pattern. The most desirable panel produced in this set had a marbled design; however, occurrence of this pattern was low, and would not be commercially viable to produce. Panels with the alternating stripe design were the least visually appealing.

The face-gluing method has limited potential for sorting, grading and pre-selection of patterns before gluing. One advantage may be higher productivity compared to that of an edge-gluing process when blue-stain pattern is not critical.

Conclusions

There is greater control over panels' final appearance by re-sawing stained mountain pine beetle dimensional lumber into strips and then edge gluing them than by face gluing lumber into blocks and re-sawing them into panels.

The two most visually appealing blue stain patterns were natural streak and marbled. Both patterns resembled boards custom cut for flooring or panelling, and had an advantage of dimensional stability provided by narrow strips. Uniform and uniform stripe patterns were somewhat desirable patterns. The least visually appealling were panels with the alternating stripe pattern.

It should be noted that beauty is in the eye of beholder, and the ultimate decision on appeal of appearance of a certain pattern will lie with the customer. A marketing study is recommended to gauge market preferences.

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References

Petersen, L. 2004. Mountain pine beetle epidemic in BC: from a timber supply perspective [online]. BC Ministry of Forests, Forest Practices Branch. Presentation to UBC on Feb 12, 2004. Available from http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/symposium/cf.pdf. [Viewed 4 March, 2004]

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Appendix: Description of patterns

No stain: no trace of blue stain in the wood

Uniform: stain is equally distributed along the length and width

Very Uniform: stain is equally distributed along the length and width more than uniform

Uniform stripe: stain covers an area about half in width on each lamina along the full length

Alternating solid stripe: stained pieces are mixed with unstained pieces alternating

Random: no determined pattern

Marbled random: marbled lamina with no determined pattern

Marbled: has the look of marble

Random scattered: lamina contains small amounts of blue stain that are arranged with no determined pattern

Few scattered: lamina with sparsely streaks of stain not more than 5 inches in length

Random blotched: stain resembles spots of paint thrown about without order

Natural streaks: stain is oriented so that the glue lines are not noticed

Random streaks: stain is oblong in shape and spread about without order

Gradient: stain in lamina from 0% to 100% stain from one edge to the other edge

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